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ABSTRACT

This is one of a series of units for environmental education developed by the Highline Public Schools. This unit on water is designed for seventh-grade science classes. Included are 13 lessons. Each lesson usually includes the concept of the lesson, materials needed, notes to the teacher, procedure, and evaluation activities. In addition, there are materials for making overhead transparencies and quiz sheets. The materials were tried and evaluated; evaluation data may be obtained from the Highline Public Schools. (RH)

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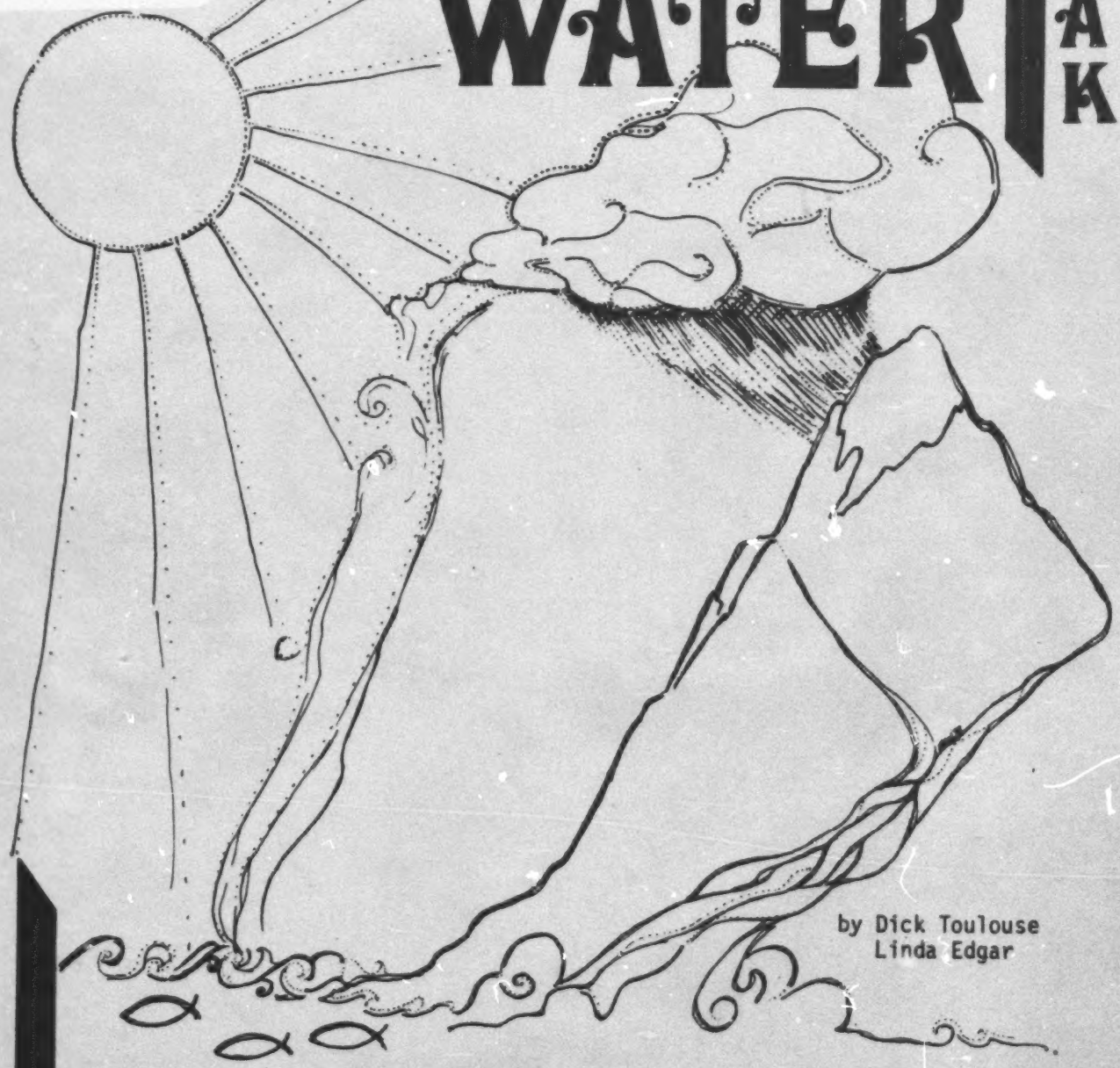
TOULOUSE & EDGAR WATER PAK



by Dick Toulouse
Linda Edgar

An Environmental Learning Learning Experience for 7th grade science. One of many ELE Paks available for all areas.

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SE 021 438

NATURE KNOWS BEST

PROJECT ECOLOGY TITLE III

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Evaluation Results Regarding This ELE May Be Obtained by Including This Page and a Self Addressed Stamped Envelope to

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EVERYTHING IS CONNECTED TO EVERYTHING ELSE • PROJECT ECOLOGY • TITLE III

EVERYTHING MUST GO SOME WHERE • PROJECT ECOLOGY • TITLE III

THERE IS NO SUCH THING AS A FREE LUNCH • PROJECT ECOLOGY • TITLE III

BACKGROUND INFORMATION

1. What are the properties of water?

   A. It solidifies
   B. It turns to a gas
   C. Odorless
   D. Tasteless
   E. Transparent
   F. Falls as precipitation
   G. A necessity of life

2. What is the hydrologic cycle? The hydrologic cycle is the cycle of water as it evaporates, condenses, and falls as precipitation.

3. How does a sewage treatment plant work?

   A. Primary treatment is largely a mechanical process. Larger floating objects and debris are removed from the water by a filtering screen. The waste and sewage then pass through settling chambers where impurities settle to the bottom and become sludge. Only about one-third of the impurities and contaminants are removed from the water by primary treatment.
   B. In the secondary treatment of water, it flows over a bed of rocks 3-10 feet deep. As the water trickles through the rock filter, the bacteria found in the sewage multiply rapidly. These bacteria cover the surfaces of the rocks and consume most of the organic waste found in the water. Secondary treatment reduces the organic wastes in the water by 90% or more.
   C. As water leaves the sewage treatment facility, chlorine is added. Chlorination of the water kills up to 99% of the disease germs, but does little to improve the taste and smell of polluted water.

MATERIALS BY LESSON

Lesson			
1	Overhead projector		
2	10 ml beaker	short glass tube	wire screen
	100 ml beaker	rubber tubing	overhead transparency - Hydrologic Cycle
	one-hole stopper	bunsen burner	
	flask	ring stand	
3A	Pea/Radish seeds		
	2 petri dishes per experiment		
	filter paper		
3B	pond water (with Daphnia or Rotifer)		
	15 microscopes		
	slides, cover slips		
	metryl cellulose (can be used to slow down organisms)		
4	1 large container, ½ full of water		
	motor oil (a few ounces)		
	detergent (2-3 tbsp.)		
	fertilizer		
	food coloring		
	tissue paper		
	Quiz #2 ditto		
5	Any household product that adds to water pollution		
	small organisms (students will collect these)		
6	transparency - Thermal Pollution Index		
	fish		
	bunsen burner, large beaker		
	thermometer		
	Quiz #3 ditto		
7	Game from Man and the Environment		
	ditto - Roles		
	ditto - Game rules		
	ditto - Data blank on Serena Lake		
8	film - Aging of Lakes		
	transparency - "Changes in Chemical Characteristics and Fish Production in Lake Ontario"		
9	water testing kit	bunsen burner	
	agar	water samples	
	petri dishes	Quiz #4	
	inoculating hook		
10	transparency (Hydrologic Cycle) and Water Flow		
	15 funnels		
	15 cotton balls		
	sand		
	15 baby food jars		
	polluted water		
	sink		
	overhead projector		
	screen		

11 bunsen burner
polluted water (filtered from lesson 10)
rubber stopper
glass tube
large jar
small jar
ice
goldfish
flask

12 sewage plant dittos/transparency

13 data blank on Lake Erie

CONCEPTUAL OVERVIEW

1. As populations increase the use of water increases.
2. Water in its pure form is clear, transparent, boils at 212° F (100° C), condenses below 212° F and freezes at 32° F (0° C)
3. All living things depend on water to live.
4. Water pollution is mostly caused by man.
5. Pollutants in water affect the lives of living organisms.
6. Heat is a water pollutant and affects some living organisms.
7. As industry increases and more heat is poured into the water the quality of life decreases.
8. As lakes age nutrients are added that decrease the survival of life.
9. Water can be tested by the Health Department to determine whether it is polluted.
10. Nature's filtration process filters pollutants from the water.
11. Nature's evaporation process helps clear pollutants from the water.
12. Man has created ways to remove pollutants from the water.
13. Lake Erie has changed over time because of eutrophication and man's addition of pollutants.

NOTES TO TEACHERS

The lessons in this Pak are designed to take approximately three weeks. Doing the extra activities will lengthen the Pak somewhat.

Should the materials listed on the master list not be available to you in your school, they can easily be obtained from your home or local store, with the exception of pond water containing protozoa. However, ponds are numerous and the teacher, with a little searching, can obtain this.

All films and filmstrips listed are available from E.R.A.C.

SLIDES AND FILMS

1. Slides 1-47 from "The State of the Environment" (Lesson 4)
2. Film "Aging of Lakes" (Lesson 8)

LESSON 1

CONCEPT. As populations increase the use of water increases.

MATERIALS: Overhead projector, calculator (not necessary, only handy)
Each students' data on the amount of water they used in one day

NOTE: The first part of this lesson is to introduce to the student how much water they actually use in one day. Part 1 of Lesson 1 may be given as a homework assignment the day before this lesson so the information will be available to discuss.

PROCEDURE: (Homework assignment)

1. Ask: How much water do you use in your house to:
   a. take a bath
   b. take a shower
   c. flush the toilet
   d. fix dinner
   e. wash dishes
   f. any other activity you use water for?

2. Tell the student to use a plastic gallon or half gallon container to measure the quantity of water he or she uses for each activity.

3. Leave "how you measure" the water up to the student. This experience yields some interesting stories the next day.

4. Ask the students to put their results in a chart like the one below.

Activity	Amount of Water Used (Gallons)
Bath	

Total amount of water used in one day _____gallons

5. The next day the students should present the amount of water they used in one day. An average of the amount of water used by the students in one day can be calculated. (NOTE: usually 50-60 gal/day/person is used.)

   a. Ask: *How much water would your family use in a month?*
   b. Ask: *How much water would 10 families use in a month?*
   c. State: You have 10 families that use _____ gallons of water in a month. In 10 years how many people do you think will be sharing the same area of land that those 10 families are sharing? (say 15) Ask: *How much water would those 15 families be using?*

EVALUATIVE ACTIVITY:

1. Discuss: What does more people or an increased population mean about the amount of water being used?

2. If more people means more water is being used, where are we getting the water? (Introduce the water or hydrologic cycle) This question should lead into lesson 2 which is concerned about the properties of water and the hydrologic cycle.

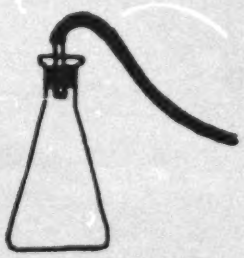
LESSON 2

CONCEPT: Water in its pure form is clear, transparent, boils at 212° F (100° C) condenses below 212° F, and freezes at 32° F (0° C)

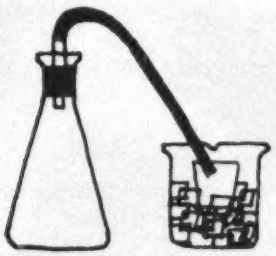
MATERIALS: Overhead transparency of Hydrologic Cycle and handouts of Hydrologic Cycle
10 ml beaker
100 ml beaker
one hole stopper to fit the flask used
flask
short glass tube
rubber tubing connected to the glass tube
ice
bunsen furner
ring stand
matches or burner lighter
wire screen
thermometer
Student - should have paper and pencil

PROCEDURE:

1. Each student should take out a piece of paper for observation.
2. Have a beaker of water in front of the room.
3. State: *Describe this water in every way you can.*
4. Light a bunsen burner and place it under a ring stand. Put the flask of water on a wire screen on the ring stand. Wait for the water to boil.
5. Ask: *What is happening here?* (The water is boiling.) *What else is happening?* (The water is evaporating. The water is turning into a gas)
6. Ask: *What temperature does the water boil at? How do you find out? Measure the temperature of the water.* (100° C)
7. Place a stopper (with a short piece of glass tubing through the hole) in the flask. Attach a piece of rubber tubing to the short piece of glass (as shown in Fig. 1 below)



8. Ask: *What is coming out of the tube?*



9. Set up the apparatus as shown in Fig. 2 above.

10. *As the gas comes out of the tube and goes into the beaker what happens to it?* (turns into water - condenses)

11. Ask: *How cold does the temperature have to be for water to turn into a solid?* (32^{0} F or 0^{0} C)

12. Take out several flasks with various clear liquids in them (DON'T tell the students what's inside the flask.)
    Some examples of what might be used.
    1. alcohol
    2. acetone
    3. water + salt or sugar or both
    4. bleach

13. Ask: *What do we have inside each of these flasks?* (some students may say water) *How could you find out?* (by finding the boiling point, freezing point, smell, etc.) At this point you could divide the class into groups and have them try to identify these liquids.)

    After the liquids have been identified you may ask what effect adding these liquids would have on the purity of your water.

EVALUATIVE ACTIVITY:

1. Quiz #1

2. Give the students a picture of the Hydrologic cycle. Have them describe what is happening at each letter. (10-15 min.) Discuss what they have decided with an overhead transparency and overlays of what is happening.

7. What three cycles are shown here?

RAIN & SNOW

RAIN & SNOW

SNOW MELTS

PLANTS GIVE
OFF WATER

WATER EVAPORATES
OFF LAND & WATER

STEAMS FLOW
INTO LARGER
BODIES OF
WATER

PLANTS
TAKE IN
WATER

WATER GOES THROUGH
PIPES TO STREAM

PEOPLE & PLANTS GIVE
OFF WATER

ANIMALS
GIVE OFF
WATER

INDUSTRY
DUMPS WATER INTO STREAMS

ANIMALS
DRINK WATER

PLANTS WATERED

QUIZ #1

Define these terms in your own words: (5 pts.)

1. Evaporation

2. Condensation

3. Freezing point of water

4. Boiling point of water

5. Physical properties of pure water

There is rumor that the temperature of the earth may increase. Would this temperature increase have any effect on the Hydrologic Cycle? Why or why not?

LESSON 3

CONCEPT: All living things depend on water.

MATERIALS:
A. Pea or Radish seeds (any that germinate quickly)
2 petri dishes (any flat clear dishes will do) per experiment
filter paper or paper toweling - enough to fit all petri dishes
B. Pond water with Daphnia or Rotifers in it - or any organism large enough for the student to see
eyedroppers
microscopes (15 - if whole class does the activity)
slides, cover slips - methyl cellulose - (only if you want to slow the organism down)

NOTE: You may want to divide the class into 2 groups and have each group do one of the activities. A third and fourth group may also be developed if students have their own ideas about how to test whether a living thing is dependent on water. Also: If the students have had no experience with the microscope the Appendix to Lesson 3 might be done previous to this lesson.

PROCEDURE: PART A - Seed Germination

1. Ask: *Do seeds need water to germinate or begin growing?*

2. Give each student (they may do this activity in pairs or groups of 3) 2 petri dishes and 10 seeds of the same kind.

   - At this point: if you have done experiments with controls before you might ask the students to set up the experiment to test whether seeds need water to germinate.

   - If they have not had much experience with this ask them to do the following:

   a. Place a piece of filter paper in both petri dishes.
   b. Place 5 seeds of the same kind in each petri dish and spread them apart.
   c. Label one dish experiment - Don't do anything else to this dish Label the 2nd dish Control - add just enough water to soak the filter paper.
   d. Put both petri dishes in the same environment - preferably a place that is warm and has some sunlight.

3. Have the students make a chart like the one below and check and record the progress of their seeds each day.

Do Seeds Need Water to Germinate?

	Day 1	Day 2	Day 3	Day 4	Day 5
Control (water)					
Experiment (no water)					

EVALUATIVE ACTIVITY:

1. What effect does water have on living things? If you altered the water by polluting it, what effect would this have?

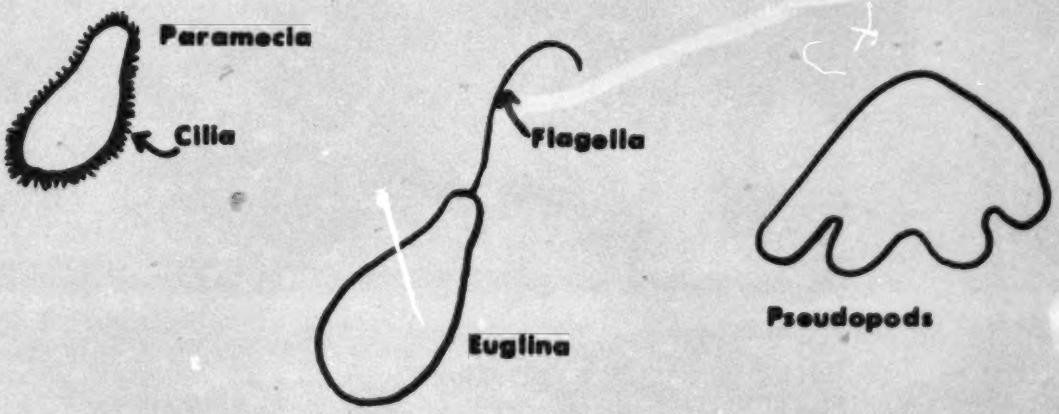
PROCEDURE: PART B - Do animals depend on water?

NOTE: Daphnia can be purchased at a biological supply house but are found in any pond that has a lot of vegetation around it.

1. Have the students take a few drops of pond water and examine it. If a light source is put behind the container where the organisms are some small animals might be seen and easily caught.

2. Ask the students to note how the animals move.

3. Ask the students to note how the animal eats. Any 7th grade biology text should have information on CILIA, FLAGELLA, and PSEUDOPODS. See the diagrams below. All of the animals move by causing a current to form. (If students are interested to see a daphnia eat - they love yeast. If you put a little yeast in some methyl red as the yeast goes through the daphnia's digestive tract it will turn orange. The daphnia eats by causing a current flow and the animals flow into its mouth.)



4. Ask: *What do animals need to survive?*

5. These students may be given the assignment to find 5 pictures showing the need that all living organisms have for clean water.

EVALUATIVE ACTIVITY:

Discuss the necessity of water in living things using the pictures that the students bring in.

You may ask the students to invent an animal or plant which doesn't need water.

SUGGESTED EXTRA ACTIVITIES:

Some animals or plants can get along with very little water. Students may do some research to find out how much water different animals depend on.

LESSON 3 APPENDIX

CONCEPT: The microscope allows man to see microscopic animals.

MATERIALS: (for each pair of students)
Glass slides and cover slips
Lens paper
Paper toweling
Medicine dropper
Microscope
Ditto of microscope for each student
Newspaper
Scissors
Ditto of evaluative questions

PROCEDURE: Hand out ditto to each student. The teacher should have a microscope to work with before the class. The object of this lesson is to familiarize the students with the parts of a microscope. The students should fill in the parts of the microscope marked on their ditto as the teacher names and explains these parts to the students.

1. Ocular - this is where the student looks to see his slide material
2. Body tube
3. Coarse Adjustment
4. Arm
5. High and low power objectives
6. Stage clips
7. Stage
8. Mirror
9. Base

The teacher should now explain how slides are made for viewing by a microscope. Materials to be studies are placed on a piece of glass called a microscope slide. In most cases the material is covered with a small, thin piece of glass called a cover slip. Clean both carefully before using. Wipe the slides clean with water and paper toweling. Clean the cover slips with water and lens paper.

Now pass out to pairs of students a microscope, scissors, small piece of newspaper, slide and slide cover, medicine dropper filled with water.

Have the class prepare a wet slide as you explain to them how.

Steps to follow:

1. Cut small piece of newspaper with letter e with scissors.
2. Place on slide, printed side up.
3. Using medicine dropper, put single drop of water on paper.
4. Place cover slip over newsprint.
5. Place slide under stage clips of microscope.
6. Look through ocular.

7. Using coarse adjustment, slowly move the tube up or down until newsprint comes into focus on letter 3.

EVALUATIVE ACTIVITY:

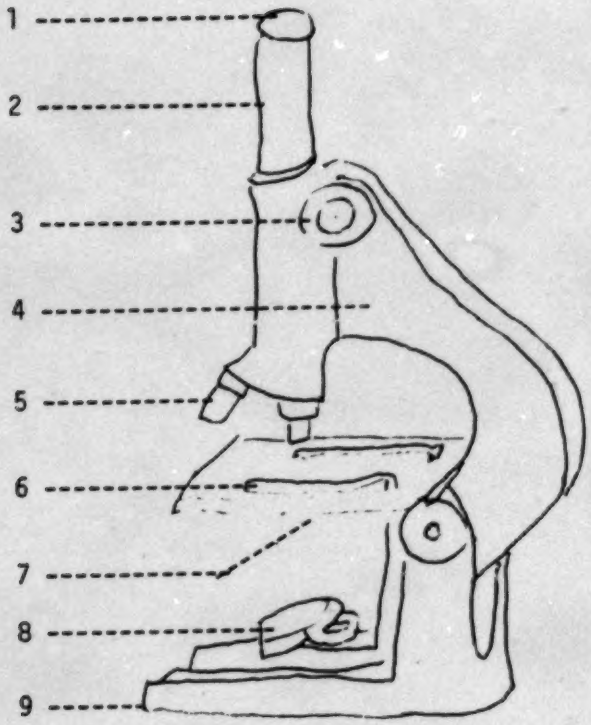
Questions to ask students: Ditto

1. Is the letter e upside down or is it in the same position as it would be when seen with unaided eye?

2. Move the slide from right to left. Which way does the e move?

3. Move the slide away from you. Which way does the e move?

Use different powers and note the appearance of the e.


1
2
3
4
5
6
7
8
9

LESSON 4

CONCEPT: Water pollution is mostly caused by man.

MATERIALS:
1 large container ½ full of water
some motor oil (a few ounces will do)
some detergent (2-3 tablespoons)
some lawn fertilizer (2-3 tablespoons)
food coloring (1-2 tablespoons)
1 pint of the polluted water that killed the goldfish
tissue paper
Quiz #2

PROCEDURE: Begin by asking students to provide answers to the question they were to have written paragraphs on. Provide short discussions on their reasons, which probably will include such things as industry dumps their wastes into the water, sewers run into lakes and rivers, oil tankers sink or leak, ships and ferrys do not provide for wastes, but rather dump raw sewage into waterways, etc.

Place the large container of water on a table before the class. Tell them that this represents the water supply (a large lake) of a nearby city. The city depends upon petroleum products and agriculture to provide the people with a living. No sewage treatment plant.

Can solid wastes in any way add to water pollution? (yes)
Where are most solid wastes deposited in our country? (dumps or sanitary landfills)
Where does the water falling on the dump as rain go? (into the ground - as ground water)
What is usually working on garbage to break it down? (bacteria)
What could be washed off of this garbage as the rain comes down? (bacteria)
Where might this bacteria go? (into the water)

Show slides 1-47 "The State of our Environment"

EVALUATIVE ACTIVITY: Quiz #2

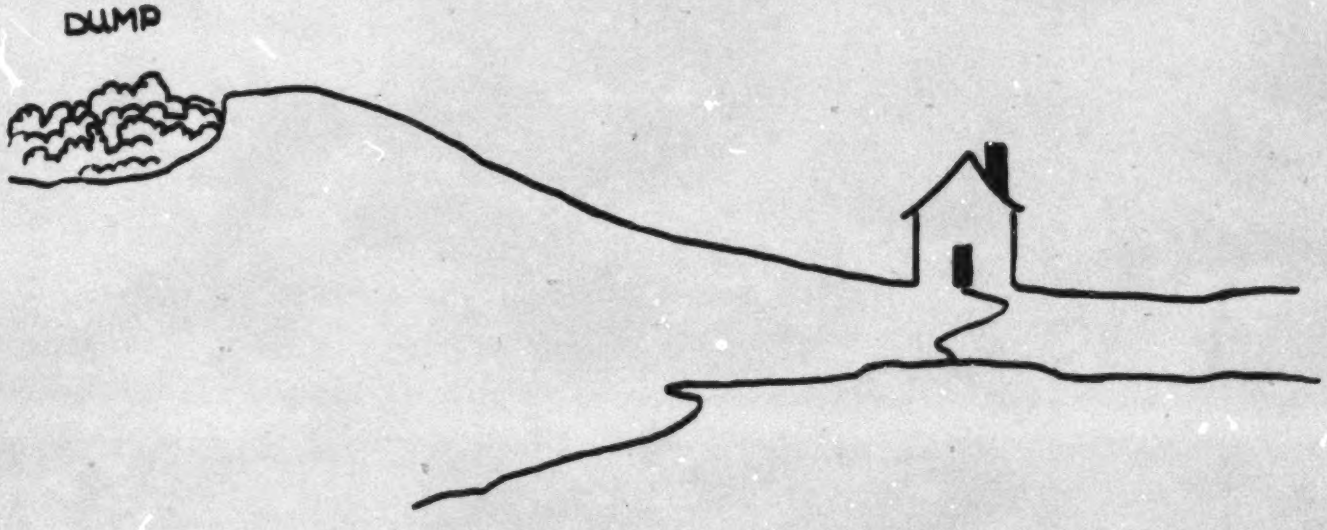
SUGGESTED ACTIVITIES:
1. Find out who is responsible for enforcement of pollution laws. What might the penalities be for breaking laws?
2. What are the 3 most important things that this class can do to prevent water pollution? Discuss.
3. Draw posters to discourage water pollution.
4. Test streams surrounding dumps or garbage sites for pollution. Compare these streams to areas that do not drain a dump.

QUIZ #2

1. Water pollution is mainly caused by who?

2. We put several items of pollutants in our lake. (oil, detergents, fertilizer, chemicals.) List 3 of the items and the source of the pollution.

3. You have a dump one block from your home located on a hill. Do you have any cause to worry about that dump polluting the beautiful lake in front of your home? Explain why or why not.



TIME: 2 class periods

LESSON 5

CONCEPT: Pollutants in water affect the lives of living organisms.

MATERIALS: Any household products that add to the pollution of the environment:

- paint
- bleach
- soap
- comet
- auto polish
- dishwashing soap, etc.

Possible organisms: Should be collected by the student.

- algae
- seaweed
- leafy aquatic plants (see list below under Procedure)

PROCEDURE: Introduce the experiment with these ideas from Lesson 4.
Read to the student: Think about the materials that you probably add to the water or soil. For example, when washing the car, fertilizing your lawn, taking a bath, or even brushing your teeth, you add new substances to your environment.

The soaps, toothpastes, and chemicals along with human wastes, go into a drain or sewer. Some cities have sewage plants to partially treat the wastes. But whether the wastes are treated or not, most of the substances you add to the water cannot be removed. The sewer finally empties into a lake, river or ocean. Some chemicals get into the water in another way. Fertilizers and weed killers often sink down through the soil into underground water sources. This water eventually drains into streams and lakes. Do you think these chemicals affect our waters and the living things in them? Do you think about pollution when someone spreads weed killer on your lawn, or when you run soapy water bath down the drain? Should you? This experiment will help you find out how you affect your environment.

1. Tell the students that they may choose a partner and work on an experiment to find out how common household products affect living things.
2. The figure below gives you some examples of organisms you could study and effects to look for. You can select other organisms if you want. Plants and animals that live nearby are best. If possible collect the organisms you decide to test.

POSSIBLE ORGANISMS	POSSIBLE EFFECTS TO STUDY
algae, seaweed	growth rate, color change
leafy aquatic plant	growth rate, color change
hydra	rate at which it regrows
flatworms	rate at which it regrows
snails	growth rate, reproduction rate
daphnia	heartbeat rate
brine shrimp	growth rate
crayfish	growth rate, breathing rate
larvae of aquatic insects, mayflies, dragonflies, mosquitos	rate of development
frog sperm and frog eggs	fertilization rate (number of eggs that start to hatch)
tadpoles	rate of development
young, local fish	behavior, breathing rate
goldfish	breathing rate

3. Here are 4 suggestions that might help your students with their investigation.

   a. Select a product to test and an organism to test it on. Find out about the normal behavior of your organism and how to care for it. (where it lives, the type of food it eats, if its an animal) The library is a good place to look.

   b. Write out a plan for your investigation. Decide on how much of the household product you will use. You might test different amounts of chemical on your organism.

      1 ml of chemical 200 ml of water
      .1 ml of chemical 200 ml of water

   c. Run your experiment. Observe your organism very carefully. Look out for pollution effects you did not plan to test for. If it looks like the chemical is seriously harming your plant or animal, stop the experiment and put the organism in clean water.

   d. Write up a report:
      Purpose of your experiment: To find out what effect (product) had on (organism).
      Procedure: Write out what you did to test whether your product was a pollutant that affected your organism
      Data: Keep accurate records of all that happened to your animal - make charts or tables if you have a lot of data.
      Analyzing Data: Write a short report of your experiment and what you found out from it. For example, did you find that your substance killed plants or slowed plant growth? Could your substance have worked differently if it was found in a more natural environment?
      Conclusion: Report your results to the rest of the class.

EVALUATIVE ACTIVITY:

The report under conclusion should be the evaluation.

What suggestions can you make to reduce your family's contribution to local pollution?

SUGGESTED EXTRA ACTIVITIES:

1. If a student is interested in photography he or she might take pictures of the way pollutants are affecting the lives of other living things in their community. These can be posted around the school with captions.

2. A slide show may be developed around the theme "Water Pollution Kills" and put to appropriate music.

3. Write a commercial about water pollution. Present the commercial to the class or an audience of your choice. What effect did it have?

4. Some students might want to make a wall mural or collage of pictures showing the effect of water pollution.

5. Waterborne wastes affect plants. Set out several flats of plants in individual pots. Dissolve equal weights of various detergents in water and allow the solutions to sit, uncovered, for a week. Use the detergent solutions to water the plants. Is there a difference on the effect various brands have on plants?

6. Do the same experiment as in #5 except using a fish - at first signs of distress remove! Let the detergents age for a week and see if this makes any difference on the effects.

LESSON 6

TIME: 30 minutes + some time for discussion

CONCEPT: Heat is a water pollutant and affects some living organisms.

MATERIALS:
Transparency: Thermal pollution index
Ditto for students: Thermal pollution index
Fish
Bunsen burner
Large beaker
Thermometer

PROCEDURE:

1. Using no words - put the fish into a beaker and begin to heat it with a bunsen burner - a thermometer should be placed in the beaker to make sure the temperature does not rise above 76°F.

   This is sure to catch most of the student's attention and get some negative responses.

2. Watch the fish as the water gets warmer. Ask: *Do the movements of the fish change? Does the breathing rate change?*

3. Remove the heat!

4. Hand out the ditto: Thermal Pollution Index

5. Ask: *What does the diagram indicate about the effect of heat on life?* (The temperature must not be higher than 75°F. or damage to life begins to occur).

EVALUATIVE ACTIVITY: Quiz #3

SUGGESTED EXTRA ACTIVITIES:

1. Choose a local industry that produces wastes. Choose one of those wastes. Then find out all you can about the methods being developed to control the waste. Write to the manufacturers of pollution control equipment and obtain information about the control of waste. (One source is Chemical Engineering, a special "deskbook" issue on the topic, "Environmental Engineering - A Complete Guide to Pollution Control". Oct. 14, 1968) If you have found a method that might work write a polite letter to the manager of the plant and tell him about your concerns and ideas for improvement.

2. Choose a local industry that has an outlet into some nearby water. Measure the temperature of the lake, river or ocean near the source of the industrial pollution. Is the thermal pollution produced detrimental to life?

THERMAL POLLUTION INDEX

	COLOR	
70° F	Blue	Normal river temperature: Water is clear. Many kinds of fish, other animals and plants thrive
75° F		No obvious change in water quality or organisms living in it.
78° F	Blue	Almost no fish can reproduce.
80° F	Green Blue	Many desirable kinds of fish such as trout have been killed.
85° F		No swimming
90° F		Most kinds of game fish and animals that live on the river bottom have been killed.
93° F		Only carp and catfish survive
95° F	Blue Green Gray	Unpleasant odors and tastes produced by increasing numbers of blue-green algae.
100° F	Green Gray	Water not fit for drinking
105° F	Gray Brown	Water can no longer be used by industry for cooling unless it is first certifically cooled.
110° F	Brown	The river is dead except for some bacteria, algae and mold.

QUIZ #3

(10-15 minutes)

You are a large business tycoon and have a chance to expand and build a new industry. You are also a fantastic fisherman and love trout! There are the possible industries you have to develop. Which industry would you choose and why?

	Thermal Pollution	Money
A. Iron & Steel	2^{0}	½ million
B. Chemicals	$.5^{0}$	¼ million
C. Oil Products	$.5^{0}$	¼ million
D. Railroads	1^{0}	$50,000
E. Buggies & Wagons	0^{0}	$ 1,000

As technology progresses, what do you think happens to thermal pollution?

LESSON 7

CONCEPT: As industries increase and more heat is poured into the water systems, the quality of life decreases.

MATERIALS: Man and the Environment (book), pages 302-325

PROCEDURE:

1. This lesson involves the students as a decision making power. The decision is whether or not to allow a new power station on Serena Lake to be built. The city needs more power (electricity) but heat from more power might damage the environment.

   a. The Wattson Electric Company is planning to build a huge power station on Serena Lake.
   b. Atomic energy will supply the heat for making electricity.
   c. Waste heat will be given off as hot water.
   d. The company doesn't plan to cool the water before piping it into the lake.
   e. Before the company can begin operations it must get permission to release heat into the lake. This is granted by the state Health Board.
   f. Some citizens don't want the State Health Board to grant the permit.
   g. Other groups support the power company.
   h. This activity is the hearing that is called by the State Board of Health to decide between these 2 issues:

      (1) Should the Wattson Electric Company be permitted to go ahead with its present plans for discharging hot water into Serena Lake.
      (2) Suppose the company is not allowed to add hot water to the lake. There are other ways to get rid of the waste heat. Will any of these methods be allowed?

2. First - 5 State Board Officials will be elected by the class. One will act as chairman for the hearing. It is their responsibility to decide if the company can release water into Lake Serena.

3. Second - list the following groups on the board:
   Wattson Electric Company
   State Industrial Association
   Majority of City Council
   Committee to Save Serena Lake
   Minority of City Council
   Friends of the Environment
   Students may volunteer for the position they wish to. (3-5 per group is a good number)

4. Have each student read the rules, pp. 303-304, Man and the Environment

5. Each person should read a description of his or her role, pp. 304-313.

6. Each person should read the Data Blank on Serena Lake, pp. 313-322, Man and the Environment, and the effects of the proposed atomic power plant upon its environment.

7. Each group must have an important understanding of its role. Each person must be able to find the appropriate data in the Data Blank which supports his position.

8. Class time should be given at this time to plan strategies, and learn the rules. (One period)

9. The hearing should be run as completely as possible by the students.

10. Look for the kind of attitudes and values that will determine behavior outcomes. Are statements made that defend or challenge viewpoints based on data or emotion.

11. The game will take one period to run.

EVALUATIVE ACTIVITY:

After the hearing is finished, it should be discussed. The most important data is on how people behave when a decision has to be made. Have the students analyze their own action in the debate. Then discuss these questions:

a. In your opinion what was the most convincing evidence made to the board?
b. What should be the role of special interest groups?
c. What problems arise in conflict between desires for prosperity and an unspoiled environment.
d. If you held a new hearing with a new Health Board could you change the outcome?

SUGGESTED EXTRA ACTIVITIES:

1. In 1899 Congress passed a law (33 U.S.C. sec. 407-411) making it illegal to dump anything into a navigable waterway or it's tributaries without a permit from the Corps of Engineers. If you find that a company does release wastes into a stream by you, you can write to the District Engineer, Army Corps of Engineers (phone book) and find out if they have a permit.

LESSON 8

CONCEPT: As lakes age nutrients are added that decrease the survival of life.

MATERIALS: Film: Aging of Lakes
Overhead transparency of Changes in Chemical Characteristics and Fish Production in Lake Ontario.

PROCEDURE:

1. Show film, Aging of Lakes (14 min.)

2. Discuss Eutrophication
   a. *What happens to bodies of water when nutrients are added to them?* (Aging occurs - and algae grows)
   b. *What happens to the lake as the algae grows thicker?* (The algae cuts out sunlight and other plants die which need this sunlight. The algae also used up CO_2 which is needed by the plants causing them to die.)
   c. *Where do the dead plants go?* (They sink to the bottom and decay is started.)
   d. *What helps decay the dead plants?* (bacteria decay the dead plants)
   e. *What does this process of decay require?* (oxygen)
   f. *As more plants die what is needed in greater abundance?* (more O_2 for decay)
   g. *What happens to the fish and other animals that need O_2?* (They don't get enough O_2 and they start dying)

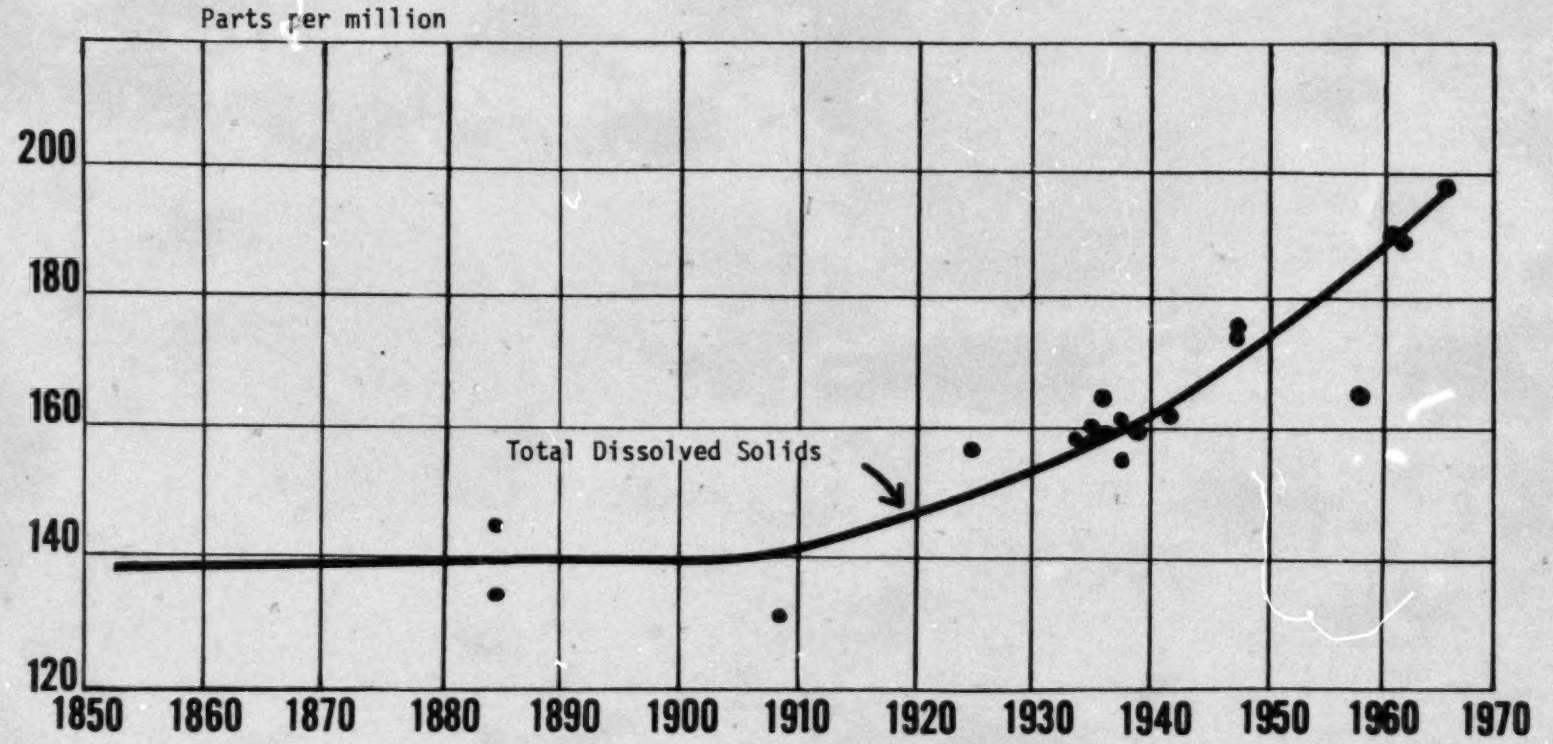
3. Show graphs of changes of Lake Ontario. Discuss the effects of increased nutrients over the years to the amount of fish in the lake.

EVALUATIVE ACTIVITY:

1. Students may draw a cartoon showing a lake and what happens as eutrophication occurs.
2. *What chemicals do detergents contain?* (Phosphorus, nitrogen) *What kind of organism is stimulated to grow by these nutrients?*

SUGGESTED EXTRA ACTIVITY: One effect man has on streams and rivers is to increase the amount of sediment due to erosion. Devise an experiment to determine the effects of sediment on algae.

CHANGES IN CHEMICAL CHARACTERISTICS AND FISH PRODUCTION IN LAKE ONTARIO



SOURCE: The Limits to Growth
by Meadows et al
Potomac Associates Book, 1972
page 82

LESSON 9

CONCEPT: Water can be tested by the Health Department to determine whether it is polluted.

MATERIALS: If you can obtain a water testing kit from a nearby pool.
agar
petri dishes
inoculating hook (sterile wire)
bunsen burner
samples of water from students' homes

PROCEDURE:

1. Explain to the children that water can be tested in swimming pools with kits. These tests are made to determine how much chlorine is in the water and what the pH of the water is. If there is no chlorine in the water bacteria can multiply and algae can grow.

2. A second test is usually run by the Health Department. Take a sample of the students water in a test tube. This water is taken to a lab. A loop like this (inoculating loop) is sterilized - place it in the flame - and a hoopful of water is then placed on an agar plate.

   a. Ask: *What is an agar plate used for?* (To grow bacteria on)
   What kind of bacteria might be found in water? (Type that decays dead organisms)

   There is another type that is called coliform bacteria and it comes from our intestine (waste products). If this type of bacteria is found on the agar then the Health Department concludes that the water is polluted and asks you to do something about it.

   b. At this point several students may wish to place their water samples on agar dishes or examine their water under the microscope for pollutants.

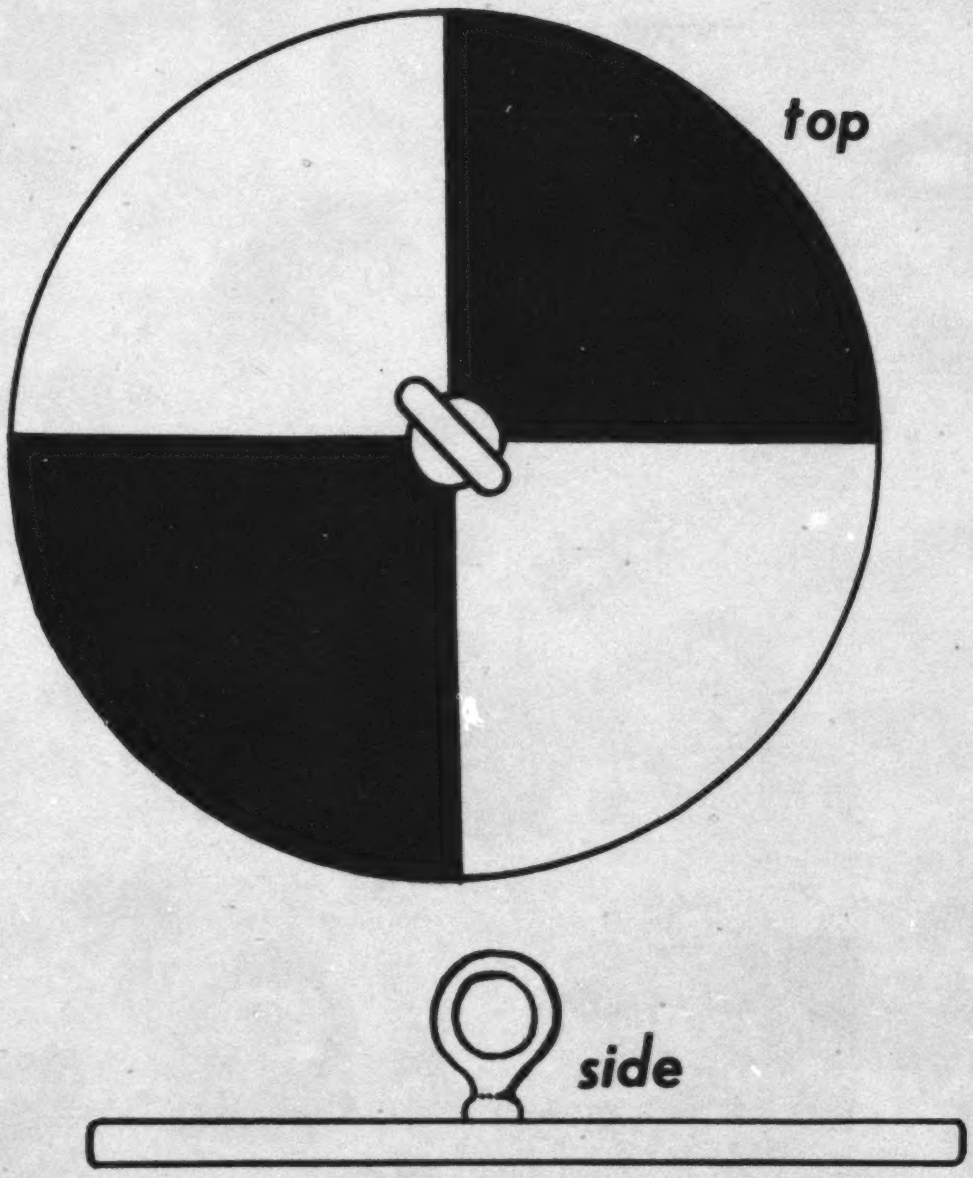
NOTE: The following books might be helpful for testing water for pollutants:
1. Standard Methods for the Examination of Water and Wastewater (13th ed.) American Public Health Association, 1971

2. Simplified Procedures for Water Examination, N.Y., American Water Works Association, 1964 (A.W.W.A. Manual M 12)

EVALUATIVE ACTIVITY: Quiz #4

SUGGESTED EXTRA ACTIVITIES: The clearness of water in lakes or the ocean is often measured using a Secchi disk. The disk looks like the diagram on the following page and is lowered deeper and deeper until it can no longer be seen.

SECCHI DISC



QUIZ #4

1. You are concerned about the number of bacteria in your water at home. How might you test the water to tell if it is pure enough to drink?

2. You are a Health Inspector and have taken a sample of water from a nearby swimming pool. The agar plate slowed that coliform bacteria was present in the water. What does this mean?

LESSON 10

CONCEPT: Nature's filtration process filters pollutants from water

MATERIALS:
Transparency of Hydrologic cycle
for 30 students (15 groups of 2)
- 15 funnels
- 15 cotton balls
- sand
- 15 small glass containers (baby food jars)
- polluted water from simulated lake experiments
- water transparency
- sink
- overhead projector
- screen

PROCEDURE:
Review the Hydrologic Cycle using transparency
Pour some polluted water down the sink
Have the students draw a diagram of where this H_2O goes

Where does this water go? Show transparency of water flow.

Show the transparency of Hydrologic Cycle

What has nature provided to remove possible pollutants? Soil filtration, sand

Will this water be free of pollutants after it filters through the soil and sand? Answers will vary

Put these materials on a counter in your room:
- 1 funnel
- 1 cotton ball
- 1 small glass container
- some sand
- some of the polluted water

Have each group of two take these materials and design an experiment that will filter the polluted water.

EVALUATIVE ACTIVITY:
Have students write out the uses of the materials and a step by step process of their experiment.

What things were filtered from the water?

What can be concluded from this experiment?

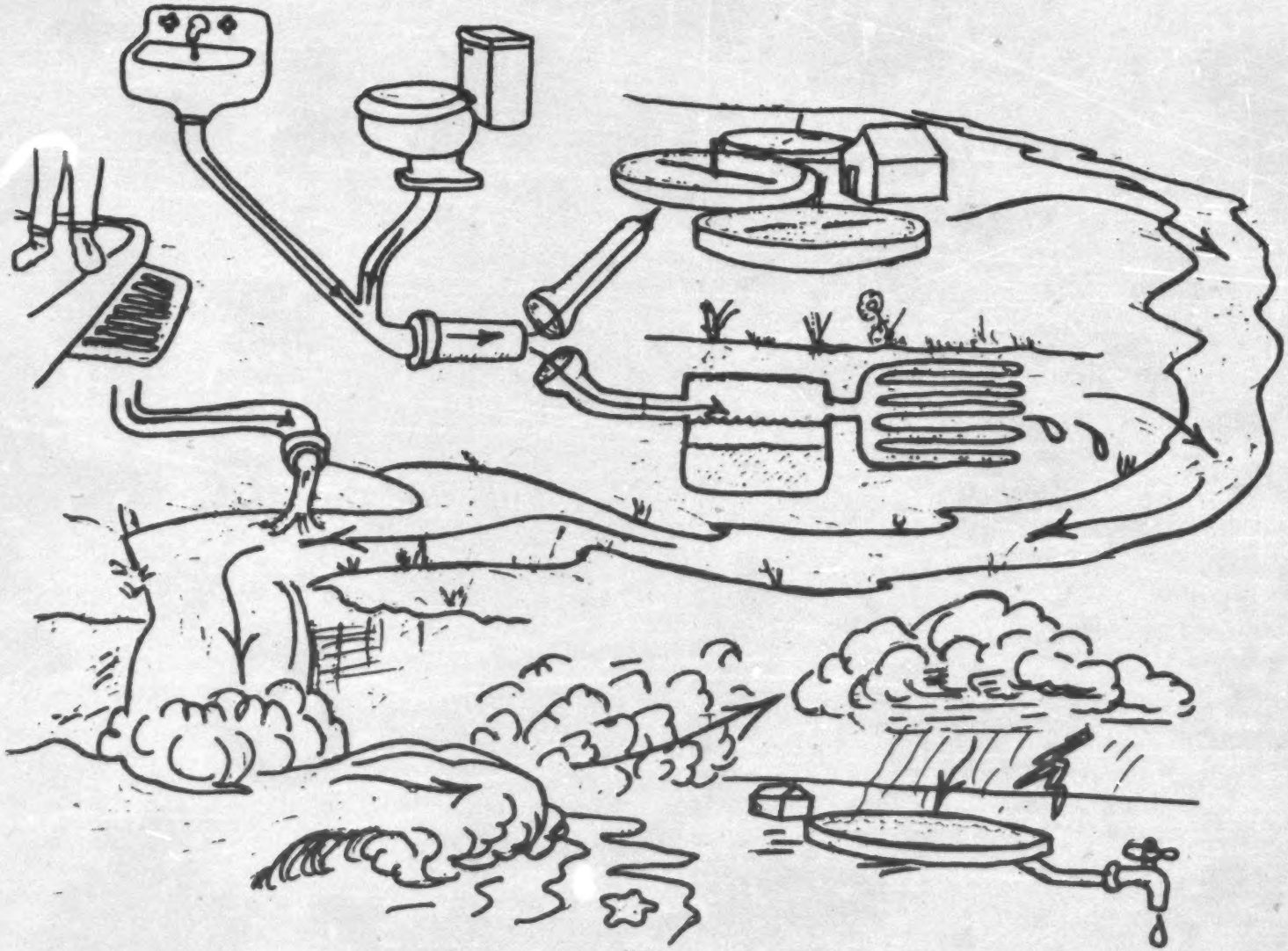
This was a small amount of polluted water. Can Nature continue to filter pollutants forever?

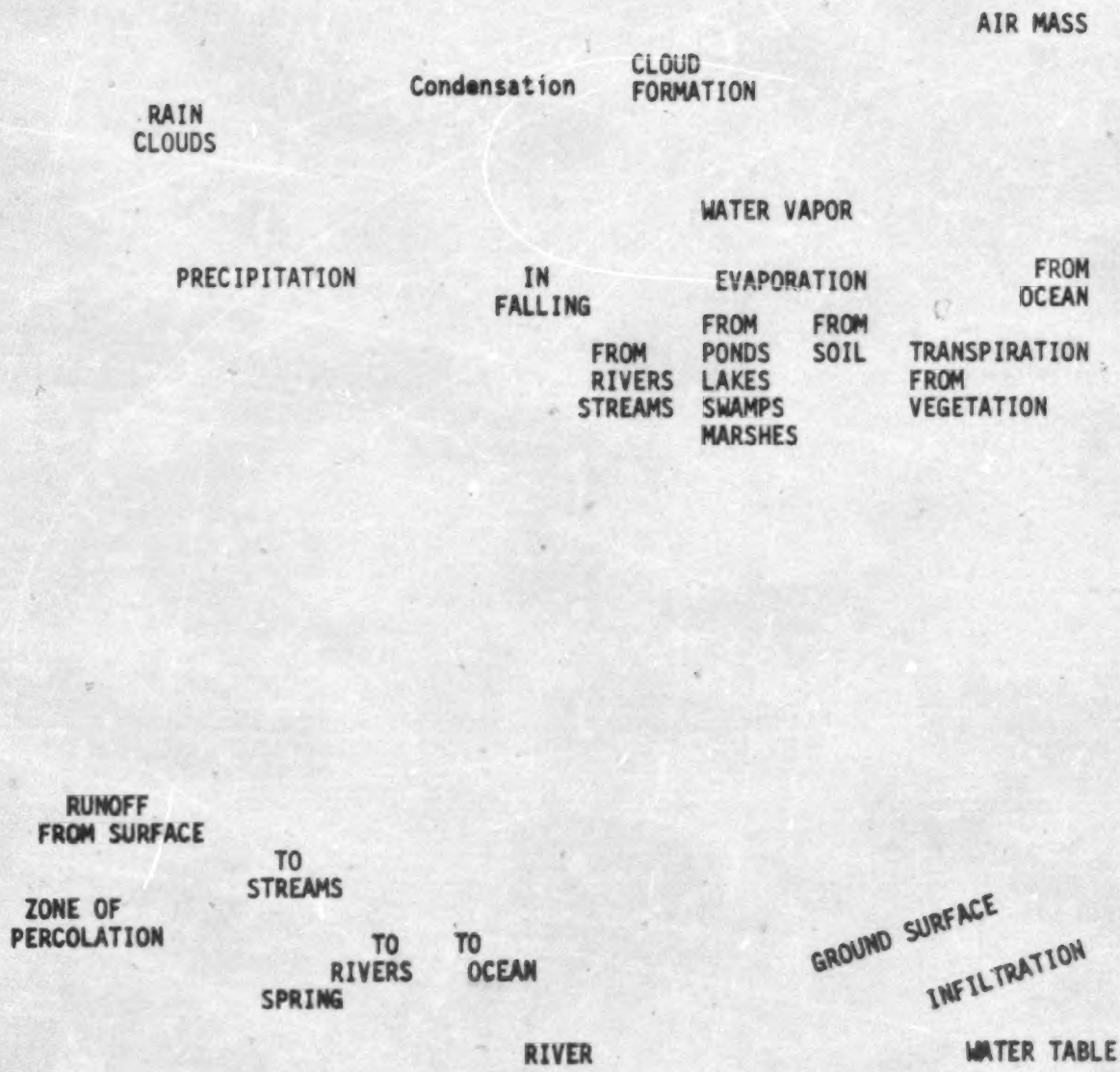
What suffers from this type of water cleansing? (The soil - the pollutants remain.)

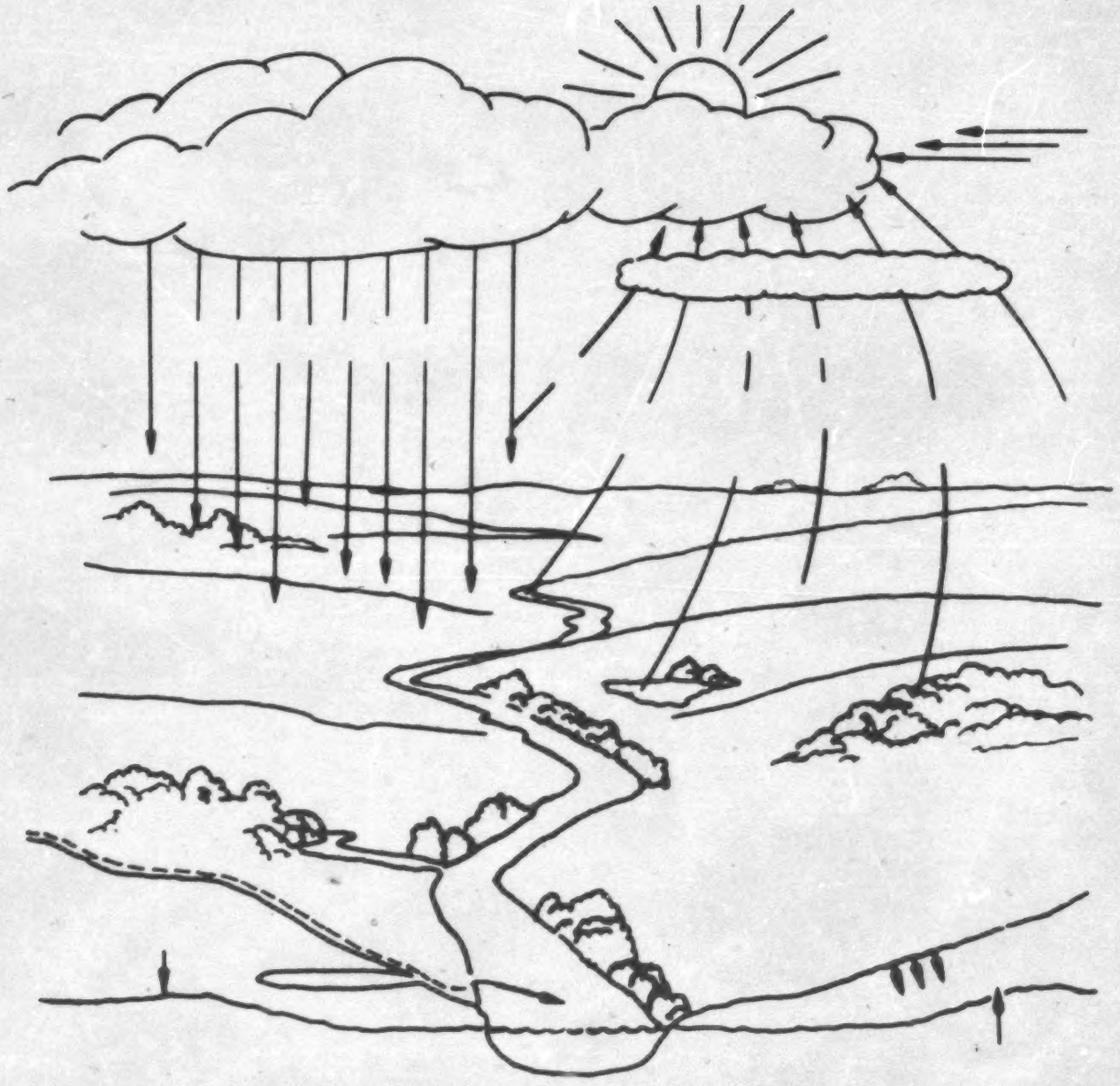
SUGGESTED
EXTRA
ACTIVITIES:

1. Take some polluted water and place in a glass dish. Allow to evaporate. This should leave the pollutant in a residue on the bottom.

2. Find some forms of water pollution that are helpful. (Minerals such as iron and sulfur are needed by our bodies.)




AIR MASS
CLOUD FORMATION
Condensation
RAIN CLOUDS
WATER VAPOR
PRECIPITATION
IN FALLING
EVAPORATION
FROM OCEAN
FROM RIVERS STREAMS
FROM PONDS LAKES SWAMPS MARSHES
FROM SOIL
TRANSPIRATION FROM VEGETATION
RUNOFF FROM SURFACE
TO STREAMS
ZONE OF PERCOLATION
TO RIVERS
TO OCEAN
SPRING
GROUND SURFACE
INFILTRATION
RIVER
WATER TABLE
ZONE OF SATURATION (ground water)



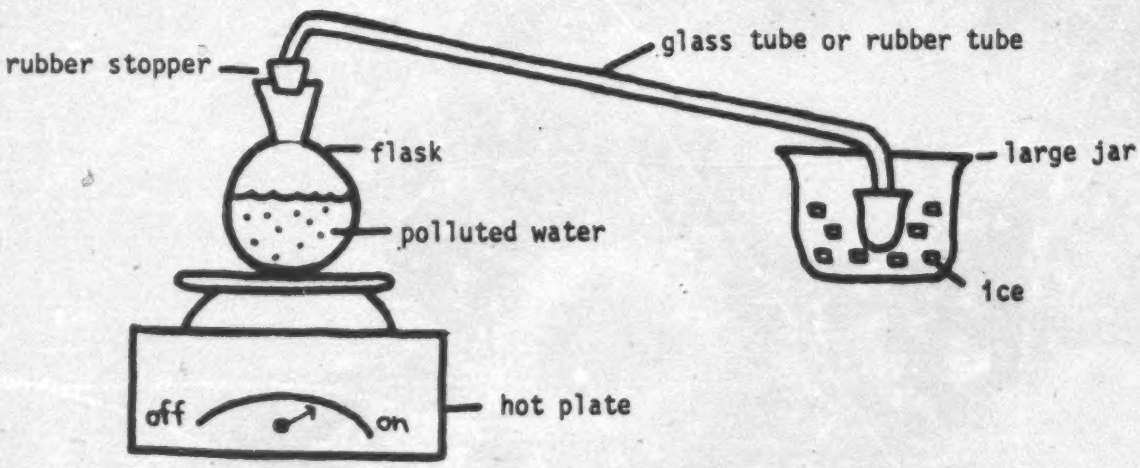
LESSON 11

CONCEPT: Nature's evaporation process provides pollution-free water

MATERIALS:
hot plate or Bunson burner
polluted water than was filtered in previous experiment
rubber stopper
glass tube
large jar
small jar
ice
goldfish
flask

PROCEDURE: Ask class to propose solution for making the filtered polluted water safe for use. The method must be one that Nature also uses. The teacher may have to direct them into this evaporation type experiment.

Set up the experiment as follows:



What is happening to the water as it boils? (Evaporates)

What happens to it as it cools? (Condenses)

Have someone explain the process Nature has: evaporation
condensation
precipitation

Take the distilled water and shake vigorously.

What am I adding to the water as I shake it?
(Air with dissolved oxygen in it)

Drink some of the water.

What is desalinization? (Removing salt from sea water to make fresh water.)
How could desalinization be done? (Boil off H_2O, then condense.)
Today it costs 10¢/1000 gallons to purify H_2O. Desalinization takes $1/1000 gallons.

EVALUATIVE ACTIVITY:

Write a paragraph explaining how our experiment is similar to Nature's hydrologic cycle. Review the Hydrologic Cycle.

SUGGESTED EXTRA ACTIVITIES:

1. Set measured amounts of water in different types of containers in areas of the room that receive varying degrees of heat. Take note of the amounts of evaporation from each container. Have students write why some containers of water evaporate more rapidly than others.

2. Try the above experiment when the humidity is very high and again when it is very low. Record results.

LESSON 12

CONCEPT: Man has created ways to remove pollutants from the water.

MATERIALS: Sewage plants dittos/transparency

PROCEDURE: Review the previous methods found in the hydrologic cycle that nature uses - filtration and evaporation.

Why does man have to create sewage treatment plants if nature already has methods for cleansing the water? The Environmental Control Administration made a survey of water supplies of 3,563 samples. 30% contained germs or chemicals in excess of federal standards. Natural processes are unable to handle the massive volume of waste and sewage being dumped.

Over 1300 communities still dump untreated wastes into rivers and streams. 25% of our communities have no treatment plants. About 30% of our population live in communities that provide primary treatment only.

Hand out Primary Water Treatment ditto and discuss this type of treatment.

PRIMARY TREATMENT

1. Filtering screens separate rags, sticks, and large objects.
2. Grit chamber: soil, rocks, sand settle to the bottom.
3. Sedimentation tanks: suspended particles settle to the bottom.

SECONDARY TREATMENT

50% of communities with sewer systems provide secondary treatment of water.

Process:

1. Water filters over bed of coarse rocks.
2. 90% of organic pollutants are consumed by bacteria.

ADVANCED WATER TREATMENT (Only a few places have tertiary treatment - Lake Tahoe is one. Less than 1%)

1. Phosphate removed
2. Nitrogen removed by blowing air through sewage
3. Chemicals remove additional phosphate in separation bed
4. Water passes through activated carbon for additional cleansing

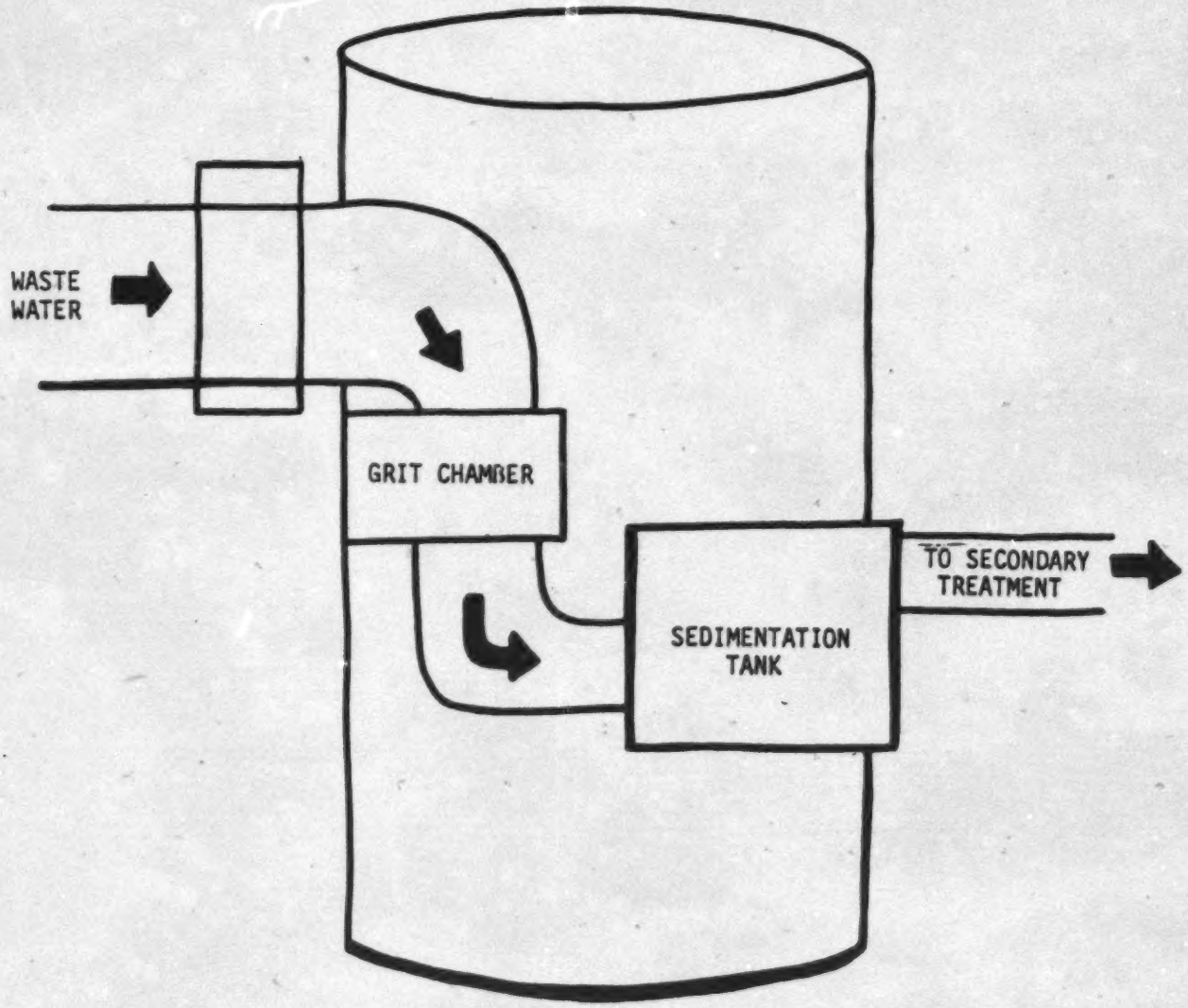
EVALUATIVE ACTIVITY: The solids that remain behind are called "sludge". What uses do we have for sludge? (Fertilizer)

1. Have students list possible uses for "sludge" in the future.
2. What new jobs will be created by this new "sludge" industry?

SUGGESTED EXTRA ACTIVITIES:

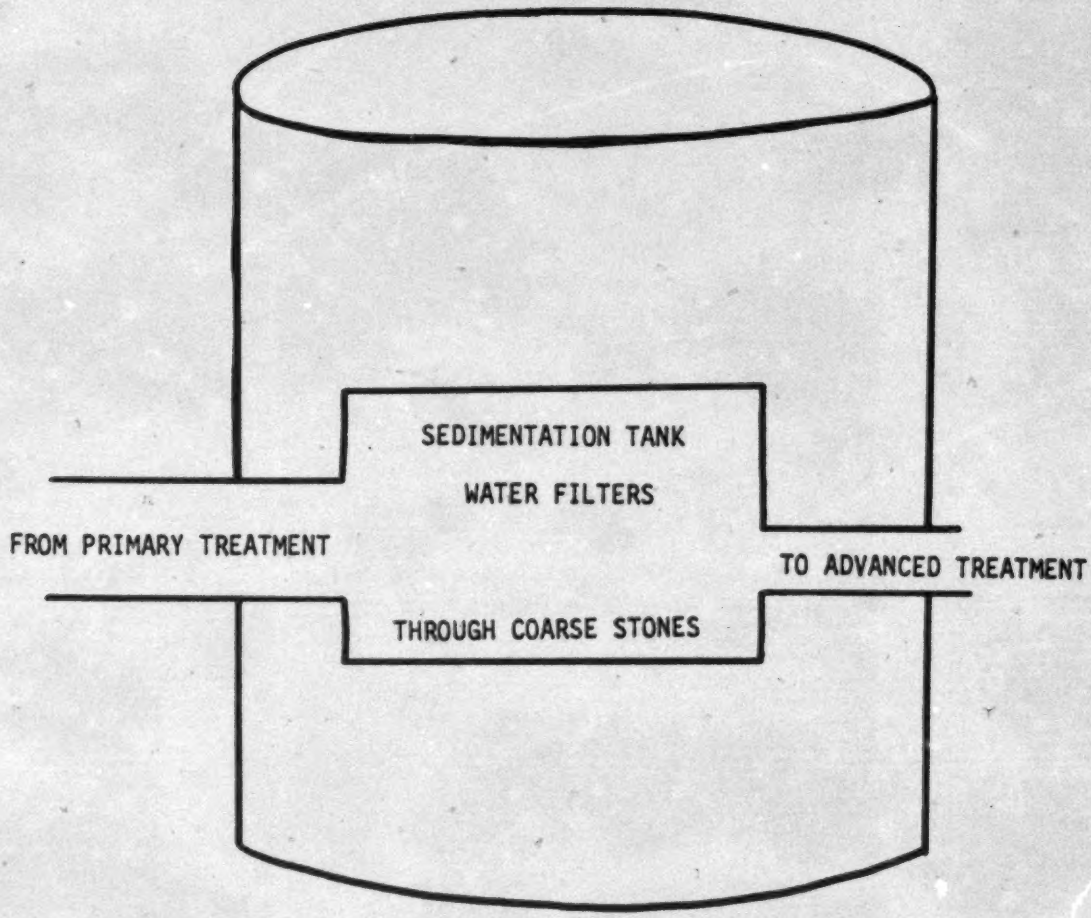
1. Take a field trip to a local sewage treatment plant.
2. Show filmstrip "Environmental Crisis", Part 2

PRIMARY WATER TREATMENT

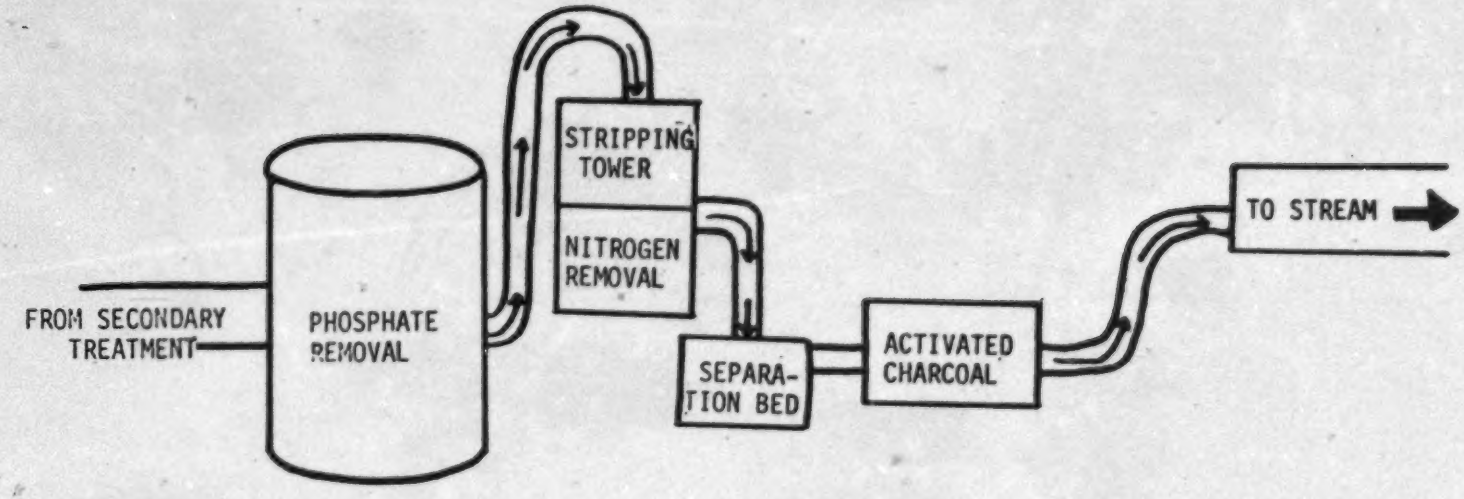


25% use no treatment
31% of communities use primary
50% use primary and secondary treatment
less than 1% use primary, secondary and tertiary treatment

SECONDARY WATER TREATMENT



ADVANCED WATER TREATMENT



LESSON 13

CONCEPT: Lake Erie has changed over time because of Eutrophication and Man's addition of pollutants.

MATERIALS: Information Data Blank on Lake Erie, pp. 265-286, Man and the Environment Ditto - Is Lake Erie Dead?

PROCEDURE: The objective of this lesson is for the students to read data about a pollution problem, figure out what is causing the problem, and propose a solution to fix it.

1. Have the students read the data blank on Lake Erie. pp. 265-280. Have them read them to themselves. Some students may need help interpreting data, and graphs or charts.

EVALUATIVE ACTIVITY:

1. After the students have read the information ask them to come up with at least one plan that would help them improve Lake Erie or answer the questions on the next page.

SUGGESTED EXTRA ACTIVITIES:

1. A series of slides (1-47) and a tape on the State of Your Environment can be found at the Highline District. This tape and slide series reviews the major concepts that have been introduced in this Pak and it is good to show them if time allows.

2. Some students may have prepared slide shows - this is usually a good time to show those.

IS LAKE ERIE DEAD?

Read the information on pages 265-281 in Man and the Environment and answer the following questions.

1. Which entries contain useful information when considering whether or not Lake Erie is polluted?

2. Lake Erie was tested for algae in several years. Has the amount of algae increased or decreased? Why? (See entry #3)

3. Entry #4 shows the type of fish found in Lake Erie. What kind of fish are increasing desirable or undesirable?

4. Entry #5 talks about coliform bacteria. Why do you think there are more bacteria near the shores than in the middle of the lake?

5. What does the process of decay use up? page 275

6. What is the amount of oxygen that will be used up called?

7. What does a primary treatment plant do? p. 276

8. What does a secondary treatment plant do? p. 276

9. Entry #9 shows the kind of organisms found in the lake over 3 separate years: 1929, 1930, 1958. Which organisms are found in higher numbers in 1929, those that require high oxygen content, low oxygen content or are they both about the same?

10. In entry #9 which organisms are found in greater numbers, those who require high oxygen content or low oxygen content, in the year 1958.

11. What does the table on page 279 for entry 11 indicate about the relationship between the amount of nitrogen and phosphorous and the growth of algae? (Does algae increase or decrease as the amount of nitrogen and phosphorous increases?)

12. Do Mastery Item 20-1. From the data which is more polluted Lake Erie or Lake Ontario?

For your convenience the films used in this ELE are listed on this tear out sheet. Simply add the dates required and mail to the Instructional Material Center, ERAC.

Project ECOLogy

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QUESTIONS 1 AND 2 OF THE FOLLOWING QUESTIONNAIRE ARE INCLUDED IN THE EVALUATION INSTRUCTIONS. THEY ARE EXAMPLE QUESTIONS AND NOT INTENDED FOR INCLUSION IN TOTAL QUESTIONNAIRE.

3. If the population of the world keeps increasing and people use more and more water, what will happen to the world's total water supply?
   a) it will sharply decrease
   b) it will only gradually decrease
   c) it will stay the same
   d) it will increase or decrease according to rainfall patterns, not population use

4. The total amount of pollution-free water on Earth is
   a) increasing
   b) decreasing
   c) staying the same

5. Approximately how many gallons of water will the average person use today?
   a) 10 - 20
   b) 30 - 40
   c) 50 - 60
   d) 60 - 70

6. When salt is removed from the ocean's water, fresh water remains. We call this process
   a) desalinization
   b) salting
   c) condensation
   d) percolation

7. Bio-degradable detergents are those that
   a) make more suds
   b) chemically break down easily
   c) pollute more than regular detergents
   d) are always in liquid form

8. Polluted water can be purified best by
   a) soil filtration
   b) evaporation
   c) primary sewage treatment
   d) chlorine treatment

9. How does evaporation affect pollutants in water?
   a) pollutants remain as residue after evaporation
   b) pollutants evaporate, causing smog
   c) pollutants evaporate causing increased rainfall patterns
   d) evaporation causes low concentrations of pollutants

10. When water falls from the sky we call it
   a) evaporation
   b) precipitation
   c) condensation
   d) dew

11. Soil filtering of water will remove
   a) liquid pollutants
   b) dissolved pollutants
   c) all pollutants
   d) solid pollutants

12. Distilled water lacks
    a) oxygen
    b) pollutants
    c) taste
    d) all of the above

13. Chlorine is frequently added to water when it leaves sewage treatment plants because this chemical
    a) bleaches the water to its natural color
    b) kills germs
    c) is a tooth enamel hardner and decay preventive
    d) restores the alkaline - acid balance
    e) is a water softener

14. The residue left after sewage is treated at a sewage treatment plant is called
    a) grit
    b) sewage
    c) phosphate
    d) sludge

15. Most living pollutants in water can be killed by adding
    a) chlorine
    b) phosphates
    c) nitrates
    d) enzymes

16. Sludge from water purification plants is ecologically useful because it
    a) makes good mortar for brick construction work
    b) can be readily made into landfill
    c) makes a good insulating material
    d) can be used as fertilizer

17. The people of a small Washington town become outraged when they hear there are bacteria present during the secondary, or "rock filter", stage of their local water treatment plant. They call you in as consultant. What do you tell them?
    a) The bacteria are an unfortunate example of man's polluting ability but can be eliminated safely from the secondary stage.
    b) The bacteria are hard to eliminate during treatment without pouring chemical poisons into the water.
    c) The bacteria are good. Without them organic wastes would not be reduced during stage 2.
    d) The bacteria are good. Without them to give off CO^2 bubbles the filtering action would not take place.

18. About 30% of the population of the U. S. live in communities that provide
    a) only primary sewage treatment
    b) only secondary sewage treatment
    c) only advanced sewage treatment
    d) no sewage treatment